July 13, 2015

VIA HAND DELIVERY

Julius Knapp
Chief, Office of Engineering and Technology
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

Re: Deere & Company Request for Limited Waiver of Part 15 Rules for Fixed Television Band Device

Dear Mr. Knapp:

Pursuant to Section 1.3 of the Commission's Rules, 47 C.F.R. § 1.3, Deere & Company ("Deere") herein seeks a limited waiver, to the extent necessary, of certain Part 15 rules applicable to fixed Television Band Devices ("TVBD") operating as low power, unlicensed devices in the 470-698 MHz band. Deere requests this limited waiver to implement an innovative application of TV white space technology using fixed TVBDs manufactured by Koos Technical Services, Inc. ("KTS") in conjunction with Deere's StarFire™ GPS-enabled terminals to meet existing unmet demand using underutilized spectrum for broadband connectivity in a machine-to-machine ("M2M") application for agricultural operations in rural areas. In a typical application contemplated under this request, an agricultural machine equipped with a TVBD will derive real-time crop and equipment data as it moves across a field and will share that data, via a low power radio link, with other machines equipped with TVBDs on the farmland and/or with the farmhouse. Given the significant size of many of the fields in which this technology will be most useful, the lower power limits applicable to portable white space devices (*e.g.*, up to 100 milliwatts) cannot support the intended agricultural use. As described below, Deere proposes a number of safeguards to ensure that the TVBDs operating under the fixed TVBD rules pursuant to the proposed waiver provide comprehensive interference protection to incumbent spectrum users.

I. Description of Proposed Use

Deere proposes to use TVBDs certified as fixed white space devices under Sections 15.701-15.715 of the Commission's Rules, 47 C.F.R. §§ 15.701-15.715, installed on off-road agricultural equipment[1] (typically tractors, combine harvesters, self-propelled harvesting ma-

[1] Off-road farm equipment means mobile, self-propelled diesel fueled or large spark ignited (LSI) equipment or vehicles that cannot be registered and are not intended for normal operation on the highway due to

chines, and sprayers), to transmit important vehicle and agronomic data and implement operational control tasks and logistics tracking. The TVBD equipment subject to this request will be affixed to agricultural equipment that utilizes Deere's StarFire™ precision navigation system operating in a network of other similar agricultural machines. The TVBDs operating pursuant to this waiver will be in-motion moving at relatively slow speeds, as, for example, a tractor moves back and forth across a field being ploughed, and communicating specific data in real-time among and between machines and between machines and the farmhouse. Among other rules, the TVBDs operating pursuant to this waiver will comply with Part 15 power limits for fixed TVBDs set forth in Section 15.709(a) (1)-(5) (*i.e.*, up to four watts EIRP).

The TVBD equipment will be geolocation-enabled by virtue of a physical wired data communication connection (such as by Ethernet, USB or serial port) with the onboard precision navigation technology that is a standard feature of modern farming equipment and, in this case, will be provided by Deere's StarFire™ guidance system.[2] The TVBD will comply with Section 15.713(f)(1) of the Commission's Rules which requires that "[p]rior to operating for the first time or after changing location, a fixed TVBD must register with the TV bands database by providing the information listed in paragraph (f)(3) of this section." 47 C.F.R. § 15.713(f)(i). As required by Section 15.713(f)(3), that registration information will include, among other things, information that specifically identifies the TVBD, its location accurate to +/- 50 meters, and contact information.[3] In all cases, it is proposed that a Deere & Company (or an affiliate) contact will be identified in database registrations for operations undertaken pursuant to this waiver.

The TVBD will not transmit unless and until it receives a channel list from the database appropriate for the registered location and then will transmit only on the channels listed as required by Section 15.713(e) of the Commission's Rules. 47 C.F.R. § 15.713(e). In compliance with Sections 15.711(b)(3) and 15.711(e), the TVBD will satisfy the registration requirement and obtain appropriate channel lists either through a direct Internet connection or, if no direct connection is available, through another fixed TVBD. Where necessary, the registration and channel lists will be provided through a series of networked fixed TVBDs affixed to other agricultural equipment operating in the field pursuant to this waiver. As required by Section

---

their weight, size and/or configuration. These machines are used primarily for tillage, planting, spraying, harvesting, or transportation of agricultural products or farm property by or for agricultural producers.

[2] Specifically, the TVBD will be connected to a Modula Telematics Gateway ("MTG") which, in turn, is connected to the Star Fire ™ system. Among other functions, the MTG distributes data to the StarFire ™ system.

[3] Registration information must include the FCC Identifier, manufacturer's serial number of the device, the device's geographic coordinates accurate to +/- 50 meters, the device's antenna height above ground level, the name of the individual or business that owns the device, the name, address, E-mail, and phone number of a contact person responsible for the device's operation. 47 C.F.R.§15.713(f)(3).

15.711(e), in all instances, the fixed TVBD will operate only on channels that have been provided for the requesting fixed device; it will not operate on channels provided for another fixed TVBD.

As the equipment moving through the agricultural field approaches the +/- 50 meter boundary measured from its original registration location, the device will automatically reregister a new location with new geographic coordinates accurate to +/- 50 meters in the database and request a new channel list appropriate for the new location. The TVBD will continue to reregister new locations and request new channel lists as necessary as the machine moves throughout a field.

TVBDs operating pursuant to this waiver will not increase the risk of interference to incumbent spectrum users. Although the TVBD device will not be anchored in a single location, it will nonetheless comply with the Part 15 fixed device requirements for reregistration and updated channel lists. The reregistration process described above is the same registration process applicable to conventional fixed TVBD operations complying with the requirement of Section 15.711(b) which contemplates reregistration of a fixed device (with updated channel lists) every time a fixed device moves outside of a $\pm$50 meter area based on its original location. In light of the slow moving nature of the in-motion agricultural equipment to which the TVBD will be affixed, the TVBDs will be able to comply with the fixed TVBD reregistration and channel list requirement in contrast to a fast-moving, fully mobile on-road vehicle.[4]

Further, if an updated channel list shows that transmissions are no longer permitted on previously used channels obtained for prior registered locations, the device will cease transmitting on the unavailable channels and transmit only on channels permitted in the updated list. The TVBD will not transmit if it moves beyond the +/- 50 accuracy limit identified for its original location and, for whatever reason, it is not able to complete a new registration or obtain an updated channel list appropriate for its new coordinates.

If the link between the TVBD and the onboard StarFire™ geolocation guidance system is interrupted for any reason, the TVBD will cease transmitting until it is able to obtain geolocation data through that connection and, if necessary, reregister to reflect new coordinates +/- 50 meters from the last registered location, and obtain an appropriately updated channel list from the database. This automatic reregistration process will ensure that the TVBD will always maintain a registration with accurate location data, and an up-to-date channel list for the equipment's location, and will only transmit on channels authorized by the database.

---

[4] In addition, given that the TVBD operating pursuant to waiver will always be controlled by the database with accurate geographic coordinates, the Deere/KTS TVBD will not increase the risk of interference to incumbent users even in the unlikely event that the agricultural equipment and affixed TVBD were moved to a nonrural area.

II. Public Interest Benefits of the Proposed Operations Pursuant to Waiver

If granted, this waiver will permit Deere to introduce an innovative application of white spaces technology using underutilized spectrum in rural areas to meet an existing, significant unmet demand for broadband connectivity in M2M applications serving the agricultural sector. As structured, the proposed unique use of white spaces technology that would be permitted by a grant of this request would not raise the potential for interference to incumbent operations protected by the Commission's Rules. A grant of this request would create an important new broadband option for M2M agricultural operations in rural areas where other communications services are often unavailable due to high infrastructure cost, lower traffic volumes, and challenging terrain.[5]

Based on testing of numerous use cases,[6] it is expected that this implementation of white space technologies will support M2M communications among farm equipment operating in-field, and a broad variety of agricultural applications aimed at increasing the effectiveness and efficiency of commercial agricultural producers' operations, optimal use of precious resources (land and water), and the preservation of the environment. In particular, the data transmitted will include real-time equipment operations and logistics monitoring, sensor status, agronomic data pertaining to the status of soil, planting, harvest, fertilizer, insecticide application and moisture levels. Through this technology, commercial agricultural producers will be able to take advantage of state-of-the-art autonomous tractor operations, real-time equipment monitoring and response to equipment service and supply demands, dealer inventory tracking, etc. Armed with this real-time, specific information, commercial agricultural producers will be able to significantly improve the efficiency of their operations and streamline work processes, materially increasing crop yields and reducing costs associated with lengthy machine and labor downtime necessary to wait for equipment diagnostics, and repair, offloading and reloading, field management instructions, etc.

---

[5] *See, generally,* Deere & Company comments in the *Matter of Connect America Fund*, in Docket No. 10-90 (filed Aug. 8, 2014). (Connect America Fund and Mobility Fund resources should be available to support enhanced broadband rural in agricultural areas.)

[6] For example, the FCC has issued a number of experimental licenses to Spectrum Bridge, Inc. over the last several years to conduct tests of TV white space devices, including tests aimed at determining the viability of such devices to support "automated agricultural machinery applications."

See OET File No. 0729-EX-ST-2012. *See also* OET File Nos. 0520-EX-PL-2012, 0123-EX-RR-2012, 0230-EX-ST-2012, 0065-EX-ST-2012, 0460-EX-PL-2011 (each concerning Spectrum Bridge tests of fixed white space devices under various scenarios and locations).

The proposed operations also makes use of the existing onboard StarFire™ precision navigation system in farm equipment taking full advantage of the highly precise navigation that enables farm machinery to plant, water, fertilize, harvest, apply pesticides and perform other tasks with minimal waste and at the maximum efficiency and yield for the land and other resources used. The geolocation data used by the TVBD and provided to the database in these operations will be more precise (measuring often less than a foot) than that generally available from other geolocation navigation systems. Further, the potential for errors in installation will be minimized because geolocation data will be continuously and automatically obtained through the equipment link between the TVBD and Starfire.™

III. Request for Waiver of Part 15 Rules

Deere seeks a waiver, as necessary, of the Part 15 Rules applicable to fixed TVBDs. In particular, Deere seeks a waiver of Sections 15.703(c) and 15.711 (b) of the Commission's Rules.[7]

Section 15.703(c) identifies the defining characteristics of a "fixed" device as a device that "transmits and/or receives radio communication signals at a specified fixed location." 47 C.F.R.§ 15.703(c). While this operation meets the specific operating rules set forth in Part 15 for fixed TV band device operations, including the rules designed to prevent interference to incumbents, Deere seeks a waiver as necessary to address the fact that the farm equipment on which TVBD transmitters/receivers are proposed for installation will be in-motion and are not "fixed" in the conventional sense. Deere is *not* seeking a waiver to install and operate fixed TVBDs in automobiles, trucks or other mobile equipment intended for high-speed operation on public roads or highways; this waiver request is limited to devices operating on off-road agricultural equipment in open fields within rural areas.

The Commission has treated other in-motion facilities under fixed rules in analogous circumstances. For instance, in 2005, the Commission authorized Earth Stations Aboard Vessels ("ESVs") operating in C-band and Ku-band fixed satellite service frequencies,[8] and Earth Stations Aboard Vehicles ("VMES").[9] Deere also seeks a waiver, to the extent necessary, of

---

[7] Deere herein requests a waiver of any other rules that the staff determines is necessary for Deere to provide the machine-to-machine service described above.

[8] *Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/11.7-12.2 GHz Bands*, IB Docket No. 02-10, Report and Order, 20 FCC Rcd 674 (2005) (*ESV Order*).

[9] *Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum and Adopt Service Rules and Procedures to Govern the Use of Vehicle-Mounted Earth Stations in Certain Frequency Bands Allocated to the Fixed-Satellite Service*, IB Docket No. 07-101, Report and Order, 24 FCC Rcd 10414 (2009).

Section 15.711(b) of the Commission's Rules which provides that a fixed device must register every time it moves +/- 50 meters from its original location. Although a Deere/KTS TVBD operating under the above-described reregistration approach would in fact comply with the specific terms of this rule because its registration would always be accurate to +/ 50 meters of its registered location, Deere requests a waiver of Section 15.711(b) to the extent that the contemplated in-motion operation is determined to be inconsistent with the terms of this requirement.

Deere also seeks a waiver, to the extent necessary, of Sections 15.711(b)(3) and 15.711(e), to allow the TVBD to satisfy the registration requirement and obtain appropriate channel lists through a series of networked fixed TVBDs affixed to other agricultural equipment operating in the field pursuant to this waiver. Generally, in compliance with Sections 15.711(b)(3) and 15.711(e), the TVBD will satisfy the registration requirement and obtain appropriate channel lists either through a direct Internet connection or, if no direct connection is available, through another fixed TVBD. However, given the size of the agricultural fields in which operation is contemplated, it is possible that a TVBD will need to acquire the necessary registration and channel lists through a series of networked fixed TVBDs affixed to other agricultural equipment operating in the field pursuant to this waiver. Deere seeks a waiver to the extent that Section 15.711 (b) is interpreted as permitting only a single "hop" in the communications with another fixed TVBD. As required by Section 15.711(e), in all instances, the fixed TVBD will operate only on channels that have been provided for the requesting fixed device; it will not operate on channels provided for another fixed TVBD.

Finally, Deere and KTS seek waiver of the Section 15.711(b) requirement that TVBD equipment must obtain geolocation data either by an incorporated geolocation capability or by professional installation. The KTS TVBD equipment to be used in this application will not always be "professionally installed" and does not possess integrated geolocation capability. Instead, the TVBD will obtain precision geolocation data via connection to the StarFire™ precision navigation system device onboard the agricultural equipment. KTS will seek equipment authorization under Part 2 of the Commission's Rules for its fixed TVBD that incorporates the software and hardware necessary to obtain geolocation data from the onboard navigation system -- a source other than manual professional installation or geolocation functionality incorporated in the TVBD itself as specified in the rules.

It is anticipated that the fixed TVBD equipment operating pursuant to this waiver will comply with all other respects of the Part 15 rules applicable to fixed TVBDs, including, for instance, the permissible channels of operation outside of the contours of protected services as specified in Sections 15.707 and 15.712 (*e.g.,* no operation on channels adjacent to assigned TV stations, channel 37 and unassigned channels adjacent or nearest 37, no operation within 1 km of registered wireless microphones, etc.), the general technical requirements in Section 15.709, (including the power and emission limits set forth in Section 15.709 (a) and (c)), the interference avoidance and database requirements set forth in Sections 15.711 and 15.713, and the antenna height above ground requirement set forth in Section 15.712(a)(3).

Deere is seeking a waiver of the Commission's Rules applicable to *fixed* rather than *portable* devices because:

- The TVBD equipment to be used in this application meets the technical requirements for fixed TVBDs, with one exception. Equipment authorization will be sought for KTS fixed TVBDs that incorporate the software and hardware necessary to obtain geolocation data from a source other than through manual professional installation or geolocation functionality incorporated in the TVBD itself.

- The architecture of the KTS TVBD is not designed to meet the technical requirements in Part 15 for portable devices.

    - The KTS TVBD does not have an integrated permanently attached antenna as required by Section 15.707(b) and the envisioned application requires the antenna to be physically separate from the TVBD. (As configured with the agricultural equipment, the TVBD radio will be installed inside the equipment cab and the antenna will be mounted on the roof of the cab.)
    - The KTS TVBD will not be certified to meet the 15.707 power and out of band emission requirements for portable TVBDs.
    - The KTS TVBD does not have an integrated geolocation capability and any geolocation capability that could be economically designed into a TVBD (such as that used in cell phones) is significantly less accurate than that provided by the StarFire ™ system.

- Operation of TVBDs pursuant to this waiver request will not require that any changes be made to the geolocation database; the database will treat the TVBD as any other fixed device submitting registrations and requesting appropriate channel lists for the identified location. Operation as a portable device subject to a waiver to operate at higher powers, however, would require the database to perform customized calculations regarding nearby incumbents to derive a channel list appropriate for a higher power portable TVBD.

- Portable devices are not required to register in the database and, therefore, no device, user, or contact information is readily available for a portable TVBD. In contrast, the database is required to collect and retain registration information in some form for fixed TVBDs for at least 90 days after the registration. The existence of retained registration data for fixed TVBDs adds another layer of assurance

that incumbent spectrum users and/or the Commission would be able to monitor potential sources of interference.[10]

Applicant notes that Section 15.711(b)(3)(ii) permits a *portable* TVBD to define a geographic area within which the same channels are available and permits the portable device to operate on a mobile basis within that area essentially creating a "geofence" that will confirm available channels within a specified boundary. This geofence registration approach offers interference protection benefits similar to the reregistration approach that Deere/KTS plan to employ. Deere and KTS are studying this approach with the intent of developing a geofence product in the future. However, the software and hardware of existing on-board StarFire™ systems will need to be modified in order to accommodate such an approach. Deere has completed in-field testing of the reregistration approach but has not undertaken the changes in software code or testing needed to implement a geofencing approach. If granted, this waiver will enable Deere and KTS to gain valuable real-world experience with white space operations conducted within specific agricultural areas which, it is hoped, will serve as the basis for determining what software and hardware changes will be required to implement a geofencing approach. Should Deere and KTS complete the work needed to implement such an approach and determine that such an approach is preferable or also desirable, they will seek additional waiver authority, as necessary, from the Commission.

Finally, on behalf of KTS, Deere also seeks a waiver to the extent necessary to allow the use of devices with equipment authorizations under Part 15 Subpart H of the Commission's Rules as fixed white space device equipment while operating "in-motion" to support the proposed uses as described above and to obtain geolocation data from the onboard StarFire™ navigation system (through a physical data communication connection such as Ethernet, USB or serial port connection) rather than through professional installation or an integrated geolocation capability. Specifically, KTS will obtain equipment authorizations to market and manufacture "fixed" white space devices with software and hardware that enables the TVBD to obtain geolocation information from the onboard navigation systems in agricultural equipment as described above, rather than from professional installation or geolocation functionality incorporated in the TVBD.[11] As discussed above, Deere's intention is to utilize such devices while "in motion" in the specific agricultural application described rather than in a permanently fixed location As

---

[10] Generally, only the most recent registration for a device is made public but Deere understands that Spectrum Bridge, the database administrator currently working with Deere and KTS, retains all registration data in some form for the purpose of error-checking and diagnostics for 90 days.

[11] *See* OET, Grant of Equipment Authorizations, Koos Technical Services, Inc., FCC Identifiers ZBGAWR-1 (granted Dec. 22, 2011) and ZBGAWR2UHF (granted June 7, 2012).

such, a limited waiver of the equipment authorizations granted to KTS is requested to the extent necessary to enable the KTS white space devices to be used in such a manner.

III. Good Cause Exists to Grant the Requested Limited Waiver

The FCC will grant waivers "for good cause shown."[12] Good cause is found where particular facts would make the strict compliance inconsistent with the public interest. To make this public interest determination, the waiver cannot undermine the purpose of the rule and there must be a stronger public interest benefit in granting the waiver than applying the rule.[13]

This request for waiver meets this standard. The proposed use would meet demand for broadband M2M data communications that cannot easily be provided by other means. Today, Deere's preferred communications technologies are cellular and satellite technologies because of their global reach. However, a significant portion of farmland is in rural areas where the terrain or other environmental factors preclude the availability of reliable wireless communications and/or in situations where cellular and satellite technologies may be cost prohibitive from a commercial agriculture producer's overall operational perspective. The proposed use of fixed white spaces technology will address this need. Indeed, Deere submits that this is precisely the type of innovative use of underutilized radiofrequency spectrum initially contemplated by the Commission in adopting the white spaces rules.[14]

Further, a grant of the requested waiver will not raise the potential for interference to incumbent spectrum users. The proposed use abides by the specific interference protection requirements set forth in Part 15. The TVBDs will rely on highly accurate geolocation capability and will communicate automatically with the geolocation database for registration of all new locations and to acquire appropriate lists of available channels. Registered TV stations, public safety, wireless microphones, cable head ends, among others, will be protected from interference as contemplated by the rules.[15]

---

[12] *See* 47 C.F.R. § 1.3. *See also ICO Global Communications (Holdings) Limited v. FCC*, 428 F.3d 264 (D.C. Cir. 2005); *Northeast Cellular Telephone Co. v. FCC*, 897 F.2d 1164 (D.C. Cir. 1990); *WAIT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969).

[13] *See, e.g., WAIT Radio, supra* at 1157; *Northeast Cellular, supra* at 1166.

[14] *See Unlicensed Operation in the TV Broadcast Bands, Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz band*, Notice of Proposed Rulemaking, ET Docket Nos. 04-186 & 02-380 (rel. May 25, 2004); *First Report and Order and Further Notice of Proposed Rule Making*, 21 FCC Rcd 12266, ¶ 29 & Appendix C (2006) (noting need to provide additional spectrum availability to support broadband deployment, especially in rural areas where alternative services may not be available).

[15] *See, e.g., Spectrum Bridge 802 19 TV White Space Working 802.19 TV White Space WorkingGroup*, TV Band Pioneers/Lessons Learned, at 3 (2010) (discussing white space device trials, and noting "to date - no interfer-

In addition, by definition, the equipment will be used only in an off-road, agricultural farming context in rural areas. Given the rural nature of these operations, Deere does not foresee that the proposed use will materially add to spectrum congestion for other unlicensed devices.[16] In fact, white spaces spectrum in the 470-698 MHz band is typically in abundant supply in rural areas and the proposed use would serve the public interest in implementing innovative, valuable broadband uses of spectrum resources that would otherwise lie fallow.

A grant of the requested waiver will enable commercial agricultural producers to take advantage of state-of-the-art autonomous tractor operations, real-time monitoring and response to equipment service and supply demands, dealer inventory tracking, etc. These improvements will give U.S. commercial agricultural producers important new tools to improve soil quality, enhance water use, and reduce environmental and economic costs through better energy, fertilizer and pesticide management. These features are key ingredients to advances in machine optimization, logistics optimization, and agronomic decision support that together will materially improve the ability of growers to achieve more sustainable agriculture, *i.e.*, materially increasing crop yield while using fewer resources. This proposed use is fully aligned with the Commission's priority policy interest in bringing innovative broadband applications to rural America[17] and represents an important example of employing underutilized spectrum resources in rural areas for broadband services that will boost U.S. rural economic productivity.

---

ence with incumbent operations"), available at: http://ieee802.org/19/pub/Workshop/Panel-C-03-Hamilla-SpectrumBridge.pdf.

[16] Deere notes that while unused spectrum in the 470-698 MHz bands is generally plentiful in rural areas, *see, e.g.*, Google Spectrum Database, *available at*: https://www.google.com/get/spectrumdatabase/channel/ (demonstrating the wider availability of white spaces spectrum for both fixed and portable device types in rural areas of the country than in urban areas), other unlicensed devices are assured of available frequencies by virtue of the Section 15.703 and Section 15.712 limitation that precludes fixed TV band devices from operating in channels adjacent to assigned broadcast channels. *See* 47 C.F.R. §15.712(a).

[17] *See, e.g., Bringing Broadband to Rural America: Update to Report on Rural Broadband Strategy*, GN Docket No. 11-16, ¶ 25 (June 17, 2011) (noting Commission's goal of further deploying broadband in rural areas, and further discussing Commission efforts to make "additional spectrum available for unlicensed broadband wireless devices in unused portions of the TV bands, where propagation characteristics that allow signals to reach farther can be particularly effective in enhancing broadband access in rural areas.")

For the aforementioned reasons, Deere respectfully requests a limited waiver of the Commission's Rules specified herein to allow use of fixed KTS TVBDs on agricultural farm equipment as described above.

Respectfully submitted,

Mark Lewellen
Manager of Spectrum Advocacy
Deere & Co.
801 17th Street, N.W., 2nd Floor
Washington DC, 20006

William M. Koss, Jr.
President
Koss Technical Services, Inc.
d/b/a KTS Wireless
1025 Greenwood Blvd, Suite 391
Lake Mary, FL 32746